AUTOTYPE COLOUR PRINTING PROCESSES

CARBRO
CONTACT CARBON
PROJECTION CARBON
WET PRINTED CARBON
ANAGLYPH PRINTS AND
TRANSPARENCIES

TRADE MARK
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AUTOTYPE
COLOUR PRINTING
PROCESSES

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Autotype Trichrome Printing

AUTOTYPE Trichrome Carbro has for many years been the pre-eminent process for producing full natural colour prints on paper. During the past few years research has resulted in a number of improvements in the original technique and in the development of entirely new processes, which are described in this book.

THE AUTOTYPE TRICHROME CARBRO PROCESS

THE PROCESS OUTLINED

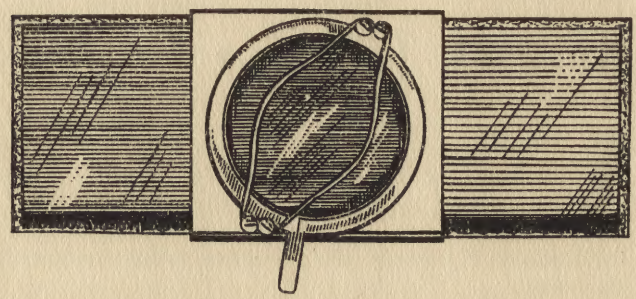
A very brief description of the Trichrome Carbro Process is as follows. Three negatives of a coloured subject are made, using tricolour filters, on panchromatic plates or films. A bromide print is made from each of these, and from them a Blue, a Red and a Yellow Carbro image. Each of these is developed on a piece of clear celluloid or other transparent plastic support. The Carbro prints are then transferred consecutively and superimposed in register on to gelatine coated paper, thus producing a full colour reproduction of the original subject.

PREPARING THE NEGATIVES

A set of three separation negatives is made using Tricolour Separation Filters, which are respectively Red, Green and Blue in colour. The plates or films (which must be Panchromatic, *i.e.*, sensitive to all colours) are exposed in turn, one behind each of the three filters.

The filters can be fitted to the Camera either in front of or behind the lens ; in either case it is advisable to focus with a filter in position, as the presence of the filter affects correct focussing. The filter generally chosen for focussing purposes is the Red, as it produces the brightest and most easily visible image on the focussing screen. The focus once set must of course remain the same while all three negatives are made.

Changing the filter on the front of the lens can be facilitated by the use of a filter attachment such as that illustrated below.



When lenses of short focal length are used to produce small negatives, say 35 mm. or 6 cm., requiring a high degree of positive enlargement, then it is most desirable that the filters should be of high quality. Filters bound between thin glasses can cause serious distortion if used under the above conditions, whereas filters cemented between optically ground glass sheets will yield negatives in register and free from distortion. Filters bound between thin glass sheets will, however, give perfectly satisfactory results if placed in contact with or just in front of the plate or film.

Gelatine filters, when new and in perfect condition, are optically satisfactory either in front of or behind the lens. Unfortunately such filters are very readily damaged, either by fingermarking or the effect of atmospheric dampness. If mounted in a paper or cardboard holder they must not be fixed with any form of adhesive but may be " sandwiched " between two suitable masks allowing some freedom of movement to avoid distortion of the gelatine.

Cellulose acetate filters are now coming into favour as they are relatively unaffected by moisture and are more robust.

Various devices have been introduced to reduce the time required to make the set of three exposures. The simplest of these is what is known as a Repeating or Sliding back. This consists of a dark slide which is moved together with a set of Tricolour filters. One large plate or three separate small plates are held in the dark slide and brought into position together with the appropriate filter for each of the three exposures.

Fully automatic Repeating backs have been made which mechanically move the dark slide and filters and also operate the lens shutter. Other devices couple the movement of filters with film winding and shutter setting.

When exposure must be reduced to the minimum to arrest movement of the subject it is usual to employ a so-called " One-Shot " camera. Such a camera has one lens and a light splitting mirror system, which divides the light from the lens into three parts and directs it on to three separate plates or films through the separation filters.

FILTER FACTORS AND EXPOSURES

Panchromatic Plates and Films must, of course, be handled and the slides loaded in total darkness. If plates are used they should be backed in order to prevent halation.

Plate manufacturers supply with their products leaflets giving the filter factors, and in making the three negatives the normal exposure decided upon is multiplied by these factors. For example, assuming the factors given (for daylight) are Red 8, Green 12, and Blue 6, and the exposure decided upon without a filter is one second, then the exposure for the Red filter negative would be 8 seconds, the Green 12 seconds, and the Blue 6 seconds.

It may be mentioned here that to obtain correct colour rendering it is essential that the subject be illuminated by one kind of light only, that is, either by daylight or by one kind of artificial light ; these sources differ so much in their composition that they cannot be used together.

Care should be taken to ensure that artificial light, if used, is capable of giving adequate illumination over the whole of the visible spectrum. For example, mercury vapour lamps should not be employed as they are deficient in red.

The filter factors given by the plate or film manufacturers take into account the spectral sensitivity of the emulsion and the transmission of the filters, and are valid only for certain specified types of light, *e.g.*, noon daylight, open arc with white flame carbons, or gas-filled electric filament lamp (" half-watt.") Any variation from these conditions must be compensated by altering the factors, otherwise the separation negatives will not be correctly balanced and may be either under- or over-exposed.

Enquiries regarding filters to be used under special conditions should be addressed to the manufacturers of the plates or films.

Each negative should be clearly marked to show which filter was used in taking it, as if they once become confused it is not easy to identify them with certainty. A simple method is to mark the negatives while still wet by " nicking " a small piece of the emulsion from the edge of the plate, making say one " nick " for the Blue filter negative, two for the Green and three for the Red.

Before leaving the subject of making the negatives it should be pointed out that great care must be taken not to move either the object being photographed, or the camera, during the making of the exposures, otherwise it will be found difficult to register the Carbros one over the other.

THE GRADED STRIP

When still-life or similar subjects are to be photographed, a graded strip or " wedge," as it is sometimes called, should be placed in such a way that it appears on all three of the negatives, but can be trimmed off the final print without affecting the composition. The Wedge usually consists of a strip of Bromide paper printed in sections of varying depth, from black at one end of the strip, through various neutral tones of grey to pure white. The reproduction of the wedge is of great value in checking to see that all three negatives in a set are equivalent in depth contrast. In a perfectly balanced set of separation negatives the wedge being entirely neutral in colour reproduces evenly in each of the three negatives, so that by comparison it can easily be seen if one is out of balance.

Such an exact balance is seldom obtained, but complete perfection is relatively unimportant so long as the density range from maximum to minimum is roughly equal in all three negatives. (The density or contrast range of a negative is measured by the difference between the density of the reproduction of the black and the white parts of the subject).

DEVELOPMENT OF THE NEGATIVES

Panchromatic material must either be developed in complete darkness or first desensitised by immersion in a suitable solution.

Although the use of a desensitiser enables the progress of development to be watched under an appropriate safe light, it is better to develop for a definite time at a known temperature. It is advisable to use the developer recommended by the plate or film makers, and to carry out development in accordance with the instructions given.

Evenness of development is of the greatest importance, and for this reason various methods have been suggested to ensure perfection, *e.g.*, brush development, mechanical and manual agitation of the developer followed by an acetic acid stop bath, and thorough fixing. After washing the negatives they should be dried as evenly and rapidly as possible. Surface moisture may be removed with a moist chamois leather, sponge, squeegee or fluffless blotting paper (all with the greatest of care) and the negatives then set to dry, using a fan and warm air to accelerate the removal of moisture.

The quality of the negatives is very important and it is desirable that they should tend towards softness rather than excessive contrast, particularly if a condenser type of enlarger is used for making enlarged bromide prints.

It is not always possible to obtain by equal development a set of three separation negatives each of equal contrast. Plate manufacturers sometimes recommend that the development times for one or more of the set should be modified, and if this is so such instructions should be carefully followed.

THE BROMIDE PRINTS

Before giving details for making these it should be pointed out that the Carbro image is produced by the tanning action of the silver image of the bromide print when in contact with the sensitised pigment paper.

Bromide paper sold for general purposes is usually provided with a supercoat or top layer of pure gelatine which is added to prevent stress marks. This coating tends to prevent the full Carbro tanning action taking place and causes loss of highlight detail. It is, therefore, advisable to obtain a Bromide paper which is specially manufactured for the Carbro Process without the addition of this supercoat.

An important factor in Trichrome Carbro is that the bromide prints *must* be made on sheets which have all been cut the same way from the roll, since paper when wetted

expands much more in one direction than in the other, and registration of the Carbro images will be *impossible* if this precaution is neglected.

Neither Chloro-bromide nor gaslight papers are suitable for the Carbro process.

Before making the actual prints which will be used for producing the Carbro images a trial contact print is made from each of the three negatives. If separate negatives are being used care must be taken to ensure that each print receives exactly the same exposure and development. When fixed these prints are examined and the reproductions of the wedge carefully compared, as this will indicate what adjustment in exposure or development will be necessary in the final prints. To get accurate colour reproduction each wedge should be of the same strength and contrast, and if they are not the exposures and developments must be modified to make them so.

For many subjects this may be done by increasing or decreasing the exposure of the bromide prints, and for such any standard developer (*e.g.*, Amidol or Metol Quinol) may be used. As mentioned above, if the negatives are not equal in contrast then it is possible to correct the contrast of the prints by using different developers.

Recommended developers are the following :

PLAIN METOL DEVELOPER FOR SOFT RESULTS

Metol	150 grains	8½ grammes
Soda Sulphite anhydrous	1¼ ozs.	30 grammes
or crystals	2½ ozs.	60 grammes
Soda Carbonate anhydrous	1½ ozs.	37 grammes
or crystals	4 ozs.	100 grammes
Water to	40 ozs.	1,000 c.c.

Use.—Developer 1 part, Water 1 part. Develop for about 2 minutes at 65° F. (18° C.).

CONTRAST DEVELOPER

Hydrokinone	150 grains	10 grammes
Metol	8 grains	½ gramme
Soda Sulphite anhydrous ...	1 oz. 55 grains	36 grammes
or crystals	2¼ ozs.	72 grammes
Soda Carbonate anhydrous ...	1 oz. 280 grains	54 grammes
or crystals	4½ ozs.	140 grammes
Potassium Bromide	40 grains	3 grammes
Water to	30 ozs.	1,000 c.c.

Use.—Developer 1 part, Water 2 parts. Develop for about 3 minutes at 65° F. (18° C.).

The English and Metric quantities are not equivalents, but are proportionate.

When making the bromide prints from which the Carbro images will be made they must be masked so that there is a white margin at least $\frac{1}{8}$ inch (3 mm.) wide round the print. This is to avoid frilling when developing the Carbros.

The exposures of the bromide prints should be just enough to give detail where wanted in the highest lights; over-exposure followed by shortened development cannot give good Carbro results.

The Red filter negative should be printed from first as this gives most information as to the type of print required, and the better the bromide print the better the finished result will be. Fogging either from an unsafe light or other cause must be avoided.

Fixing should be carried out either in plain Hypo (Sodium Thiosulphate) or Hypo to which Potassium or Sodium Metabisulphite has been added. On no account use a fixing bath containing a gelatine hardening agent such as alum.

After thoroughly fixing and washing, the bromide prints should be immersed in a 2 per cent. solution of acetic acid ($\frac{1}{2}$ oz. acetic acid, 25 ozs. water) for two minutes, and the surface of each swabbed with cotton wool and then washed.

If the final washing is insufficient the bromide print will be in an acid condition and any Carbro made therefrom will be very weak and flat. Washing of each of the three bromides must be equally thorough, otherwise Carbro prints of unequal contrast and density will be produced with consequent inaccurate colour rendering. The acetic acid treatment of the bromide prints counteracts the effect of lime in hard water and prevents marks on the Carbro images.

For full standardisation of the Carbro process it is necessary to soak the bromide prints before use in water of a definite acidity, or pH as it is usually called. This is best achieved by the use of " buffer " solution, the pH being adjusted to about 6.5. This means that the bromide print is faintly acid (neutral is pH 7) and in this condition it will yield a good clean Carbro with excellent high-light reproduction.

PREPARATION OF BUFFER SOLUTION

A formula for the preparation of a buffer solution of 6.5 suitable for use with the Carbro process is as follows :

Solution A 23.88 grammes $Na_2HPO_412H_2O$ (di-sodium hydrogen phosphate) in 1 litre of water.

Solution B 9.08 grammes KH_2PO_4 (potassium di-hydrogen phosphate) in 1 litre of water.

For use take 25 c.c. Solution B and 12.3 c.c. Solution A, which gives a solution of pH 6.5. This mixture may be diluted to 50 c.c. without any change in pH.

It must be emphasised that no buffer solution containing citric acid is suitable, as a Bromide print soaked in such a solution yields a Carbro from which the highlights wash out very readily, and the shadow tones and the end point of the development are poorly defined.

Each of the prepared bromide prints should be marked on the backs with the colour it represents, as follows : the print from the Red filter negative "*Cyan* (*blue*) *printer*," from the Green filter negative "*Magenta* (*red*) *printer*," and from the Blue filter negative "*Yellow printer*." The simple and usual practice is to mark the bromide prints respectively with the letters *R.*, *B.*, and *Y.*

TRANSPARENT TEMPORARY SUPPORTS

Celluloid (cellulose nitrate) sheets have generally been used as temporary supports as this material is relatively unaffected by hot water, but it is likely to be replaced by other and more suitable plastic materials as they become commercially available in thin sheet form. Unlike celluloid, these alternative materials do not require to be waxed in order that Carbro images may be transferred from them to paper support. Suitable plastics are "Perspex." Co-polymer (co-polymer of vinyl acetate and vinyl chloride) and ethyl cellulose.

The celluloids or other supports should be at least two inches (5 cm.) larger all round than the size of the colour print to be made. Two thicknesses are recommended, forty-thousandths of an inch (.040″ or 1 mm.) for prints 12″ x 10″ (30 x 24 cms.) and larger, and twenty-thousandths of an inch (.020″ or ½ mm.) for prints under this size.

WAXING CELLULOID SHEETS

Wax can be applied in a solution of petrol or, preferably, turpentine, and is available ready prepared, under the name of Autotype Waxing Solution. If the worker prefers a petrol-wax solution he should take 5 grains (⅓ gramme) Autotype Trichrome Waxing Compound and dissolve this in 5 ozs. (140 c.c.) of petrol or cigarette lighter fluid. It is convenient to use a sprinkler-topped bottle to contain the solution.

The waxing solution is sprinkled over the celluloid and rubbed over with a small piece of cloth to ensure a complete covering of wax. The celluloid must then be well polished with a piece of clean, soft cloth, as it is important that there should be as little wax as possible left on the surface.

Some workers prefer to use certain makes of motor car body polish, *e.g.*, " Karpol " and " Lifeguard," which serve the dual purpose of both cleaning and waxing the supports.

To obviate the danger of accidentally using the unwaxed side it is advisable to clip off small pieces from the right hand top corners of the celluloids. If the celluloids are used always in this position, both for waxing and transferring, no error can occur.

THE CARBRO PROCESS

All the foregoing instructions lead up to the actual process of producing coloured gelatine reliefs or images from bromide prints, which process is known as Carbro. Paper coated with pigmented gelatine, soluble in hot water, is bathed in chemical solutions and then squeegeed into contact with a bromide print. The chemicals react with the silver in the bromide print which undergoes a bleaching process and the reaction products tan the pigmented gelatine in proportion to the amount of the reacting silver present. Where there is much silver, as in the shadows of a bromide print, a correspondingly thick layer of pigmented gelatine is tanned, *i.e.*, it becomes insoluble in hot water. Only a thin layer of pigmented gelatine is tanned where there is little silver in the bromide print, as in the high-light portions. After the tanning operation the pigment paper is separated from the bromide print and squeegeed to a transparent temporary support. On immersion in hot water the backing paper can be removed and the untanned gelatine dissolved away, leaving on the temporary support a positive reproduction of the bromide print, in the form of a tanned pigmented gelatine relief.

While it is possible to make Carbro prints without drying the freshly made bromides it is better to dry them first, as any blemishes, dark spots and the like may be removed by scraping with a retouching knife, or sharp edge of a penknife. Light spots are not dealt with at this stage but are retouched with dye in the finished print.

If the prints have been dried they must be soaked for ten minutes before use in cold water, or preferably in a " buffer " solution at pH 6.5 for the reasons already given.

The Autotype Company Ltd. manufactures two types of Trichrome pigment paper for Carbro, SERIES 2 and SERIES 3. The SERIES 2 pigments are the more permanent, but are not so brilliant as the less permanent SERIES 3.

The chemicals can be introduced into the pigmented gelatine by bathing either in one or in two separate solutions. The former is known as the Single Bath method, and the latter as the Two Bath method. The advantages and disadvantages of these two methods are the following : Single Bath processing is somewhat more expensive as fresh chemicals should be used for the processing of each sheet of pigment paper owing to the very rapid chemical deterioration of the mixture. Single Bath processing is usually considered to give rather less brilliance than Two Bath, but should be used for repetition and large sized work, preferably in conjunction with some form of mechanical squeegee (*e.g.*, a photo. or domestic wringer, either hand or motor driven). The Two Bath method is generally recommended to amateur colour printers, and especially to those who have previous experience with monochrome Carbro processing.

Use of the Two Bath method in conjunction with mechanical squeegeeing is almost impracticable as the immersion time in the second bath is short and critical. A few seconds' difference one way or the other in this time has a considerable effect upon the depth and gradation of the Carbro image, but the same does not apply to Single Bath processing. In consequence a worker has greater latitude with timing when using the Single Bath method, which necessitates careful positioning of a chemically bathed pigment paper preparatory to squeegeeing it into contact with a bromide print with a mechanical squeegeeing device. Two Bath processing calls for the minimum of apparatus, and accurate timing and good squeegeeing technique are soon learned and applied.

STOCK AND WORKING SOLUTIONS FOR THE TWO BATH PROCESS

The authors recommend the use of the standard Autotype stock solutions A and B. These have been well tried and generally approved. Their formulae are as follows :

STOCK SOLUTION A.

Potassium ferricyanide	1 oz.	50 grammes
Potassium bromide	1 oz.	50 grammes
Distilled water to	10 ozs.	500 c.c.

STOCK SOLUTION B.

Potassium bichromate	180 grains	18 grammes
Chromic acid	40 grains	4 grammes
Chrome alum	100 grains	10 grammes
Distilled water to	10 ozs.	450 c.c.

The Working Baths are made up as follows :

NO. 1 WORKING BATH

Stock Solution A	1 part
Water	4 parts

NO. 2 WORKING BATH.

Stock Solution B	1 part
Water	4 parts

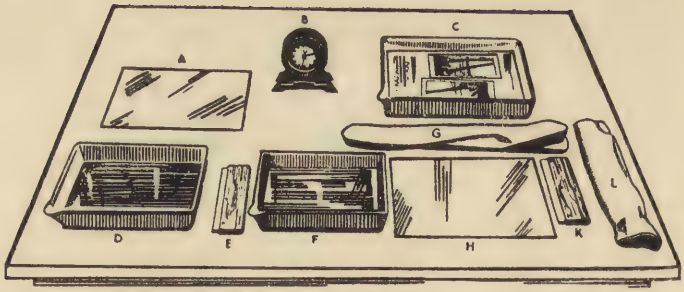
In order to get even sensitising sufficient of each of these baths should be used to cover the pigment paper fully. The No. 1 Bath may be used for a considerable number of prints, but the No. 2 Bath should be renewed after each set, as it is altered by the No. 1 solution transferred to it on each immersion. The baths should be used at a temperature of 60° to 65° F. (15° to 18° C.)., the lower temperature being preferable.

If there is any reason to suspect the purity of the available water supply then both solutions should be made up with softened or distilled water.

The pigment papers, at least an inch longer each way than the bromide prints, are placed in readiness, and the appropriate quantities of No. 1 and No. 2 baths are prepared. Do not stint the amount of No. 2 bath.

Then the celluloid supports are waxed and polished as mentioned above, a clock or watch provided with a seconds hand placed where it may be readily seen, and operations may now be commenced.

The working bench should be prepared and laid out in readiness ; the plan indicated will serve to show how this may be done.



A. Sheet of glass for removal of surplus solution from pigment paper after immersion in No. 1 bath.

B. Timing clock with minute and second hands.

C. Dish of water containing soaked bromide prints.

D. No. 1 bath.

E. Squeegee to be used in conjunction with A.

F. No. 2 bath.

G. Folded cloth on which to dab and dry squeegee K.

H. Sheet of glass for squeegeeing pigment paper on to bromide print.

L. Same as G. Also used to absorb surplus solution squeegeed from pigment paper and bromide print.

In addition to the items shown, two other pieces of glass some four inches longer each way than the bromide prints should be ready at hand for squeegeeing purposes.

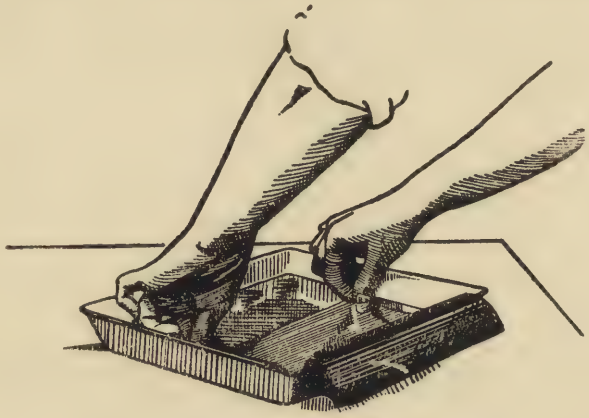
Noting the time, the blue pigment paper should be immersed in No. 1 Bath, and turned over several times to ensure even and thorough soaking, any airbells adhering to the surface being removed with the finger-tips.

At the expiration of 2 minutes with the bath temperature at 60° F. (15° C.) the blue pigment paper is withdrawn from the bath, laid face down on a sheet of glass (A) and the surplus solution squeegeed from it. It is important that the temperature of the sheets of glass should be reduced to that of the solutions. This can be done by placing them in iced or cold tap water.

Providing the weather is cool it is possible to process all three sheets of pigment paper in this way. Strip them from the glasses and hang up in clips until required for the next step of the process.

The "blue" bromide print is now removed from the dish of cold water, and laid face up on a sheet of glass, adjacent to the dish containing the No. 2 bath (H). Lightly squeegee the bromide print into contact with the glass, as this will prevent it from moving when the pigment paper is later squeegeed upon it. Finally, pour some cold water on to the surface of the print, and if necessary assist it to spread over the whole surface.

The blue pigment paper is then stripped from the glass (A) or taken from its clip, the two corners held by a finger and thumb of each hand as shown, and keeping the



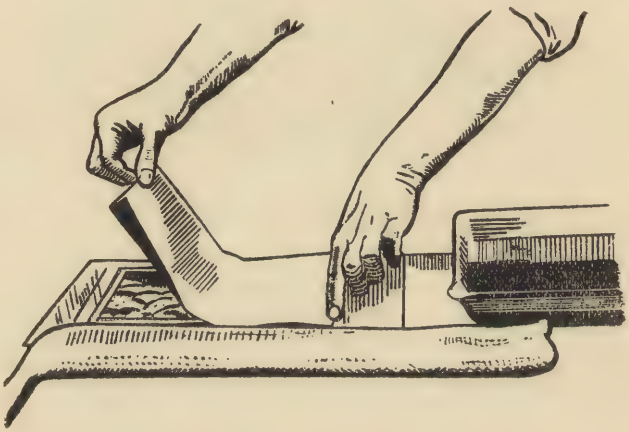
longer edge drawn taut, it is pushed face upwards under the surface of the No. 2 solution at the edge of the dish nearest the worker and drawn across to the opposite side. The dish can then be tilted so that the solution flows evenly over the surface of the pigment paper. Any air bells which cling to the surface of the coating should be removed immediately by brushing off with the finger tips. Rock the dish throughout the immersion time.

The No. 2 working bath is a "control" bath, and the time for which the pigment paper is immersed is very important. The average time is an immersion of 25 seconds a shorter immersion will result in a more contrasty Carbro relief, while a longer immersion will reduce contrast.

The time taken to remove the pigment paper from the No. 2 working bath and to place and squeegee it on to the bromide print is important, as it is in effect an extension of the

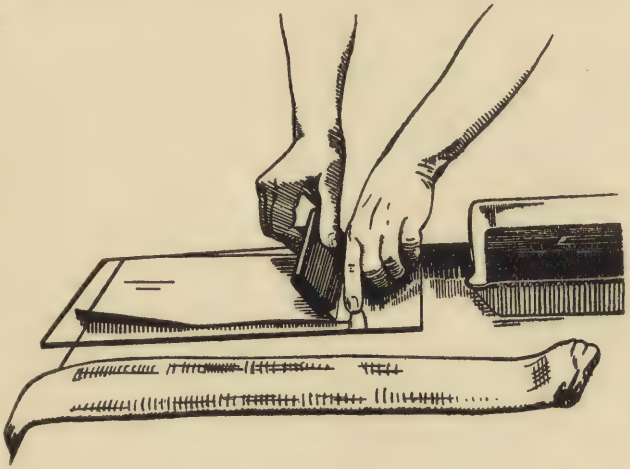
immersion period. If, for example, the worker immerses the pigment paper for 25 seconds and 10 seconds elapse before it is squeegeed to the bromide, then *the total effective time* is 35 seconds. Experienced operators need only 3 to 4 seconds to complete the squeegeeing operation, so that in the same circumstances a total effective time of, say, 28/29 seconds is achieved. Until experience has been gained, workers should reduce the immersion time to compensate for delay in positioning and squeegeeing.

At the expiration of the chosen immersion time take hold of the left edge of the pigment paper with the right hand and withdraw from the solution, turning it over so that the gelatine side comes underneath, and, as the sheet leaves the dish, seize the lower edge with the left hand, keeping the hands far enough apart for the pigment paper to be nearly flat. Lay the left edge down so that it is just clear of the left edge of the bromide print, holding it down with the finger and thumb of left hand and prevent slipping by pressing firmly on to the glass. Let the rest of the pigment



paper fall lightly upon the bromide print, seize the squeegee with the right hand and take two firm smooth sweeps from close against the left finger and thumb towards the right and then repeat from right to left. The squeegee should be dabbed on the folded cloth which absorbs surplus moisture making clean strokes of the squeegee possible. This description may make the procedure seem a somewhat

difficult one, but if the method outlined is practised, substituting two pieces of plain paper for the bromide print and pigment paper, it will be found quite simple and straight-



forward. For those who fear to damage the pigment paper when squeegeeing, a sheet of waxed paper may, after the first two strokes of the squeegee have been given, be laid over the sandwich and the squeegee firmly applied over this without fear of doing harm.

It is desirable that the " sandwich " should have most of the moisture squeegeed from it, so that when it is later peeled apart, a slight " pull " is felt. If the two sheets fall apart easily, either they have not been squeegeed sufficiently firmly, or the pigment paper has been immersed too long in the No. 1 bath.

The red and yellow pigment papers are treated similarly.

As each squeegee operation is completed lift the pigment paper - bromide print sandwich from the glass with the aid of a palette knife. Place the sandwich between sheets of greaseproof paper in a cool position and away from bright light, as the pigment papers are now sensitive to light.

The No. 2 bath is now thrown away and the dish rinsed out, and filled with cold water. The No. 1 solution can if desired be kept in a well-stoppered bottle for future use. Strain carefully before bottling.

At the expiration of 10 minutes the blue pigment paper is stripped from the bromide print. The bleached bromide print is put to wash in cold water for redeveloping and future use if desired. One of the " support " sheets of celluloid (waxed surface uppermost), or plastic sheet if used, is laid on the sheet of glass, the pigment paper is passed quickly through the dish of cold water, laid face down upon the support and squeegeed firmly with the flat squeegee. The support, with the pigment paper uppermost, is laid aside covered with a sheet of greaseproof paper and left for a further 10 minutes. The red and yellow pigment papers are treated similarly, in turn, after which they are ready for development.

The above description covers the Two Bath Carbro procedure. Instructions for Single Bath processing will now be given, followed by a description of the development, transfer and registration steps which are common to both methods.

SINGLE BATH PROCESS.

As previously mentioned Single Bath processing is recommended for large sizes, and for all work requiring close control *e.g.*, duplication and commercial colour printing.

A typical formula for the bath is one based upon a mixture of Autotype No. 1 and No. 2 monochrome Carbro baths, the formulae of which are as follows :

Concentrated Solution No. 1.

Potassium bichromate	1 oz.	10 grammes
Potassium ferricyanide	1 oz.	10 grammes
Potassium bromide	1 oz.	10 grammes
Distilled water	20 ozs.	200 c.c.

Concentrated Solution No. 2.

Glacial acetic acid	1 oz.	10 c.c.
Hydrochloric acid (pure)	1 oz.	10 c.c.
Formaldehyde 40 per cent.	22 ozs.	220 c.c.

Single Bath Carbro Working Solution.

No. 1 Concentrated Solution	1 oz.	10 c.c.
No. 2 Concentrated Solution	1 drm.	1.25 c.c.
Water	7 ozs.	70 c.c.

Add the No. 2 Solution at the last moment, just before the pigment paper is immersed. Immerse the pigment paper for 3 minutes at 60° F. (15° C.).

Control with Single Bath Carbro is obtained by :

1. Adjustment of the contrast of the bromide prints.
2. Increase or decrease of the amount of No. 2 Solution.

The alteration of bromide contrast should not be achieved by over-exposure and under-development, but rather by use of a bromide paper of different brightness, or, if this is too drastic, by the use of a softer or a contrast developer.

Control of contrast by varying the amount of No. 2 Solution added is a critical matter as this involves a variation of the acid content of the bath. In the suggested formula this also means a variation of the quantity of hardening chemical (formaldehyde) and for this reason some formulae separate the acid and formalin into two separate stock solutions. This enables the optimum quantity of hardener to be added to the combined bath whilst permitting the contrast of the Carbro to be altered by varying independently the acid content.

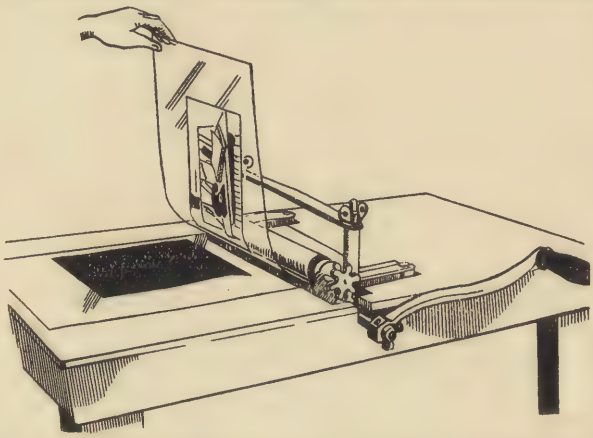
Some formulae stipulate that the pigment paper should be soaked first in water before immersion in a combined bath, but this usually necessitates carefully controlled temperature conditions and an increase of the hardening agent present in the bath, otherwise the Carbro print either loses its high lights or shows bad mottle.

Single-bath Carbro is not easy to work without a mechanical squeegee, the apparatus usually chosen being a photographic or domestic wringer, with rubber rollers. It is important to see that it works smoothly, without checks and jerks. The rollers may be arranged so that the work is fed in either horizontally or vertically, whichever is found more convenient.

It will be found, where a wringer is employed, that a " squeegee blanket " is a very useful accessory, as it eliminates troubles such as slipping and wrinkling. This may consist of a pair of suitable sized sheets of celluloid or other plastic material, from 10 to 20 thousandths of an inch in thickness, held together along one edge by means of clips or adhesive tape (with the thinner material a single piece may be used, folded in half). Guide marks may be drawn or painted on the celluloid, so as to facilitate laying the bromide prints and the pigment papers in register. It will be found a convenience to have three of these blankets in readiness, one for each colour.

The method of use is as follows. First feed the closed or folded edge of the blanket between the rollers of the wringer, and adjust the tension so that no slip can occur, but at the same time making sure that excessive pressure, which might

unduly stress the soaked and swollen gelatine on the pigment paper, is not employed. Now introduce the pigment paper into the Single Bath solution, exactly as instructed in the Two-Bath method, and remove any airbells which may cling to either surface. Keep the solution moving, and in the meantime take the prepared and soaked bromide print and lay it in position, face upwards, on one half of the blanket (if the work is to be fed horizontally it will be found convenient to place the bromide print on the upper half of the blanket). When the immersion time for the pigment paper is complete, take it from the solution and lay it, also face upwards, on the other half of the blanket, taking care that it does not come into contact with the bromide print, and squeegee surplus solution from the face of the pigment paper. It is important that contact should not take place until the moment when the bromide print and the pigment paper pass between the rollers and pressure is applied, so that the free edges of the blanket must be held apart, as shown in the illustration.



The handle of the wringer may now be turned fairly rapidly, and the complete sandwich removed and placed on one side for five minutes. (If only one blanket is in use it should be opened up and the " sandwich " laid aside between sheets of greaseproof paper, as described earlier).

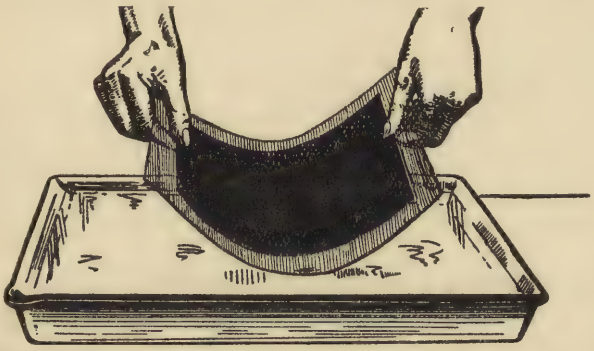
The wringer and blanket should now be cleaned up and made ready for the next print, the used solution being discarded.

Strip the bromide print and pigment paper apart after 5 minutes, and squeegee the latter to the chosen transparent

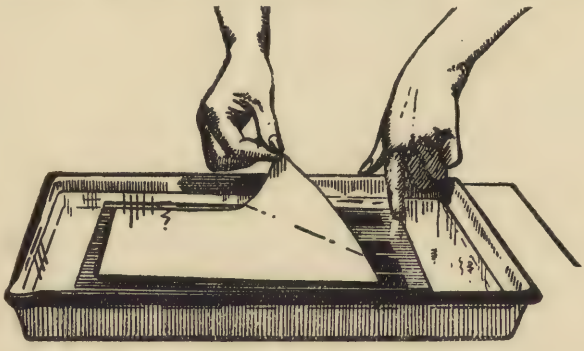
plastic temporary support exactly as described for the Two Bath process. Leave the pigment paper on the plastic and between greaseproof papers for 5 minutes before commencing development.

DEVELOPMENT.

A dish, some three inches longer each way than the supports, is filled with hot water (about 105° F. or 40° C.). The support bearing the blue pigment paper is then taken in both hands, with the pigment paper beneath and pressed down firmly into and beneath the water, so that the hot water comes first into contact with the paper backing of the tissue. After a few seconds turn the support over and again completely submerge.



When the pigment commences to ooze out from the edges this indicates that the backing paper may be stripped away



from the support, during which operation the print must be kept under the water. The support, still under

water, is then shaken with a lateral movement and occasionally lifted out until no colour can be seen running from it. It is then given a rinse in cold water and placed to dry, all surplus water being removed from the back. The other two are treated in a similar manner. Drying may be expedited by the use of a fan, but on no account introduce heat as this may cause the thicker parts of the gelatine relief to jump from the support.

REDEVELOPMENT OF THE BROMIDE PRINTS

The chemicals in the Carbro processing solutions bleach the silver in the Bromide prints. After use the Bromide prints can be redeveloped in plain metol developer, and after thorough washing they can be re-used for making further Carbro prints.

Redevelopment should not be hurried. At least 5 minutes should be given and the prints should be kept moving so as to ensure complete development. No fixing is necessary, but after washing, and before further Carbros are made, the prints should be swabbed in a 2% solution of acetic acid, or preferably immersed in Buffer solution as described earlier..

Some Workers prefer the Carbro prints made from redeveloped Bromides, particularly as there is an opportunity to make adjustments correcting any faults which may be shown up by the first set of colour prints, but it should be noted that the contrast tends to increase with redevelopment. The authors do not recommend that a single set of Bromide prints should be used for more than two sets of colour images.

COMBINING THE COLOUR RELIEFS.

The Carbro reliefs on the plastic supports are the same way round as the bromide prints, so if the reliefs are now transferred to a paper support the picture will be reversed from left to right. To correct this the three reliefs are first transferred to and combined on one piece of paper known as Soluble Temporary Support. This is a strong thin paper coated with gelatine, soluble in hot water, and a combined print may be transferred from it to any suitably coated support to give a print the right way round. The alternative to this double transfer is the making of reversed bromide prints in the enlarging camera, but double transfer has definite advantages. These advantages are :

1. Registration takes place in the order Blue, Red, Yellow, which is visually easy. Single transfer registration is done in the order Yellow, Red, Blue, and it is difficult to detect faulty register when superimposing the Red relief on the Yellow. It must be understood that in the final print the Blue must always be on top with the Red and Yellow beneath in that order.

2. Double transfer has the effect of protecting the all important Blue relief until final transfer is completed.

3. The thin smooth tough paper of Soluble Temporary Support can mould itself to the reliefs, thus picking up all detail, and final transfer can if desired be made to a rough paper surface, which is impossible by single transfer.

4. Use of a thin paper such as Soluble Temporary Support speeds up drying operations.

TRANSFER FROM THE PLASTIC SUPPORT TO SOLUBLE TEMPORARY SUPPORT PAPER.

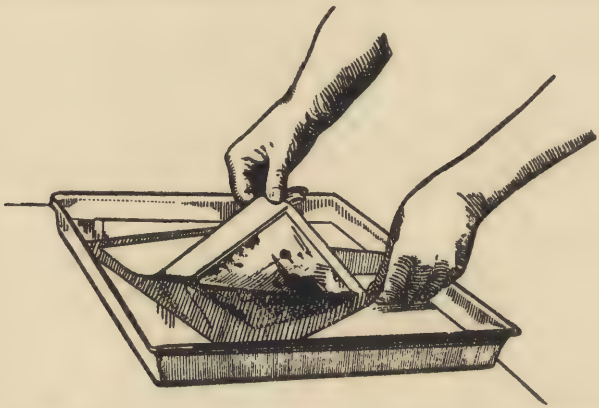
In order to obtain trouble-free registration it is highly desirable that the Soluble Temporary Support paper should be thoroughly stretched. To be sure of this first soak it for at least half an hour in cold water (60° to 70° F., 15° to 22° C.), then remove it and place it face down on a sheet of glass and squeegee vigorously in all directions with a flat squeegee, so as to stretch mechanically to the maximum. For very large sized work it is desirable to stretch the paper as described on a prepared plastic sheet and leave it to dry in its stretched condition, and then to strip it and re-soak. If a waxed celluloid is used for this purpose the wax must be removed before re-soaking in water (see next paragraph). Immediately before the soaked Soluble Temporary Support is squeegeed on to the Blue relief on its support, place the Soluble Temporary Support in a dish of water at between 70° and 80° F. (22° to 27° C.) until its coating feels slightly slimy. If colder water is used the gelatine coating will not soften sufficiently and may fail to pick up the whole of the colour print from the support. The dry blue Carbro image on the support is slid into the water beneath the Soluble Temporary Support paper and the two withdrawn together and squeegeed into contact, forming a "sandwich," which, after blotting off

all surplus moisture from back and front, is hung up to dry. When perfectly dry it will be found that the paper bearing the colour image can be stripped from the plastic support.

If waxed celluloid has been used some of the wax will have transferred to the surface of the Carbro print on the paper, and this wax must now be carefully and thoroughly removed, by rubbing it with a wad of cotton wool saturated with petrol or carbon tetrachloride. The solvent and dissolved wax are then polished off quickly with a piece of soft fluffless cloth before the solvent evaporates, and to ensure complete removal the operation should be repeated. It is essential that a piece of soft cloth be used ; cotton wool alone will not completely remove the wax.

COMBINING THE BLUE AND RED PRINTS.

The Soluble Temporary Support bearing the Blue image is now soaked in water at 70° F. (22° C.) for about 2 minutes, and the support bearing the dry Red image slid underneath it.



The two are withdrawn and moved into approximate register, care being taken to hold the paper print by the margins, as finger pressure on the softened gelatine image can cause damage. Lightly squeegee into contact. This " sandwich " is then placed on a sheet of blotting paper, support uppermost, and moved into exact register. Very exact registration can be secured if a watchmaker's magnifying glass is used, and local correction obtained if necessary by pressing with the finger tips on the transparent support as shown.

Lightly dab off with a cloth or leather any surplus moisture on either side of the " sandwich " as this will assist even and rapid drying.

THE YELLOW PRINT

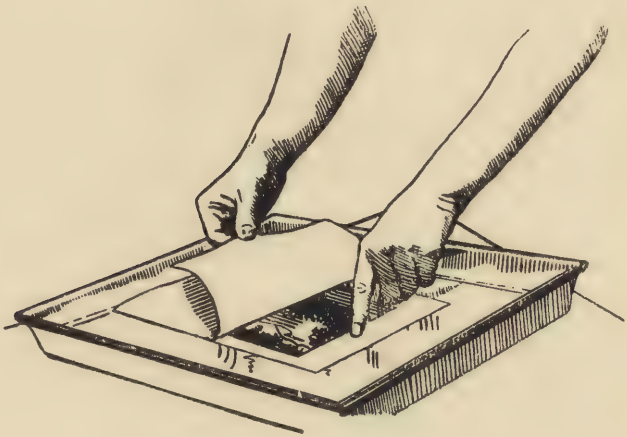
Strip the combined Blue and Red images, and after removing any wax, as previously described, the Yellow print is registered and dried in the same way as the Red.

Drying operations can be expedited by use of a fan but as the paper support has a soluble gelatine coating it is most unwise to use heat, particularly in the early stages of drying.

TRANSFER TO FINAL PAPER

A piece of Autotype Single Transfer paper, which should be cut larger than the Soluble Temporary Support, is soaked for 10 minutes in cold water. When the three combined images have been stripped from the last support and any wax removed from the Soluble Temporary Support paper, it is soaked in water for *not* more than 1 minute and squeegeed into contact with the Single Transfer paper. The two are now set aside until they feel dry to the hand, after which they are immersed in a dish of water at about 105° F. (40° C.). After a few minutes the Soluble Temporary Support is peeled off. A coating of soluble gelatine, though invisible, is left on the surface of the print, and this is removed by gently laving with the hot water. If desired the Temporary Support bearing the finished, but untransferred, picture may be trimmed to size and then transferred, so that a white margin

appears on the final support, giving a very pleasing finish to the print. When this is done rather greater care must be taken in removing the paper backing of the Soluble Temporary Support. The surest and safest method of making the



final transfer is to dry the sandwich completely, then apply a little methylated spirit to the back of the Temporary Support. When the spirit has penetrated, place the sandwich in hot water and strip the Temporary Support paper and carry out the other operations as described above.

A glazed finish can be given to the colour print by the following method. After stripping off the Soluble Temporary Support paper do not wash away the clear soluble gelatine, but dip the print into a 10% solution of gelatine containing a trace of formalin, and then squeegee to and dry out on a really clean, scratch-free glazing surface such as plate glass, new Perspex or polished chromium plated metal sheet. Do not use heat to hasten drying. Plate glass can be well cleaned by using a proprietary window and glass cleaning solution, often consisting of a suspension of french chalk or Tripoli powder in spirit.

TRICHROME PRINTING BY THE CONTACT CARBON PROCESS.

The Carbon printing process, as is well known, depends upon the insolubilising action of light on bichromated pigmented gelatine. The Trichrome pigment paper used for this process is SERIES 1A, which is suited only to Carbon printing.

The pigment paper is first made light-sensitive by immersion in a bichromate solution, after which the coated paper is dried. The sensitive pigment paper is then placed in a printing frame in contact with a negative and exposed to light. After exposure the pigment paper is wetted and squeegeed to a transparent temporary support and developed in warm water, resulting in a coloured relief of pigmented gelatine on the support. After development the coloured reliefs are combined and registered exactly as in the case of those produced by the Carbro process.

SENSITISING

The sensitising of the pigment paper is very important as the conditions under which it is carried out control the contrast in the finished print. The more bichromate absorbed by the pigment paper the softer is the finished print and vice versa.

The amount of bichromate absorbed by the pigment paper is dependent upon four main factors, which are as follows :

1. The amount of moisture contained in the gelatine coating ;
2. The temperature of the sensitising solution ;
3. Strength of sensitising bath ;

and 4. The period of immersion.

With regard to 1, the pigment paper should be stored in a cool and dry place and not left too close to a source of artificial heat such as a radiator. If the pigment paper is bought in roll form it is best kept on a shelf in a cool room or basement, or alternatively in a metal tube with a close fitting lid.

As regards 2, the temperature of the sensitising solution has an effect on the rate of swelling and the degree of absorption by the gelatine coating of the pigment paper, and it is advisable

to work with solutions at a standard temperature—low temperatures have definite practical advantages. A very convenient temperature which is quite easily obtained is 60° F. (15° C.), at which temperature the pigment paper should be immersed for two minutes. The immersion time should be increased for lower temperatures and vice versa, but it is not advised that the sensitising solution temperature should ever be permitted to rise above 70° F. (21° C.) otherwise the gelatine coating will tend to become soft and slimy and unpleasant to handle, particularly when the bichromate percentage is high. It should be noted that the highest percentage of potassium bichromate which can be held in solution is about 6%, and that if still softer results are required ammonium bichromate should be substituted.

SENSITISING PROCEDURE

The sheets of pigment paper should be cut cleanly to the desired size with sharp scissors or a photo print trimmer, or alternatively with a knife or razor blade, the paper being laid upon a hard surface. All the sheets should be cut from the roll in the same direction so as to eliminate the possibility of poor registration, due to the fact that paper when soaked expands slightly more in one direction than in the other.

In packets of cut sheets of Autotype pigment papers this point has received careful attention.

Care should be taken to see that both coated surface and the back of the paper are free from dust and paper fibres. Introduce the pigment paper into the solution and see that both sides are free from air bubbles, removing with the tips of the fingers any which may form. (*N.B.*—The constant use of bichromate solutions can give rise to dermatitis, so that it is advisable to employ a suitable waterproof barrier cream and/or to wear rubber gloves, this being especially important if the skin should be cut or grazed. Take care to avoid splashing the bichromate solution on clothing as it will rot the fabric).

Throughout the sensitising period the solution should be kept moving by rocking the dish. The best results are obtained when the surface of the pigment paper is glazed during drying after sensitising. This is carried out as follows :

Use a surface such as high quality plate glass, Perspex sheet, ferrotype plate, polished chromium faced copper, or when available Vinylite or Plexiglass. In all cases the

surfaces should be well cleaned without abrading, a mixture of Tripoli and spirit being recommended as a polisher. Ox gall solution should not be employed to assist stripping as an excess causes mottle effects, and if the solution reaches the backing paper the warm water used for developing will penetrate more readily at such spots and will cause uneven reproduction. Similarly photographic print-glazing solution should not be employed as this often contains formalin which will insolublise the gelatine coating.

Remove the pigment paper from the sensitising solution and squeegee, gelatine side down, to the glazing surface, which should have been prepared beforehand as above described, and set to dry in a cool position in a dark room. After about 10 minutes drying may be accelerated by passing a current of air over the paper with an electric fan, and after 20 minutes have elapsed the air may be slightly warmed. Aim at completing the drying within 1½ to 2 hours, and endeavour to standardize the drying period. When dry the pigment paper can be stripped from the glazing surface, and stored ready for use either lightly rolled or laid flat in a box or drawer. As a general rule it is best to use the paper within a few hours of sensitising but if necessary it may be kept for one or two days. It is now sensitive to light, and accordingly care should be taken in handling.

VARIATIONS IN SENSITIVITY

The sensitivity of the sensitised gelatine will increase progressively with storage until it becomes insoluble so it is obviously desirable to use within a limited period of say one or two days.

Sensitivity is increased and useful life shortened if the coating is allowed to absorb moisture and for this reason the sheets should be stored in crisp condition in a sealed tin box or tube or airtight cupboard. Do not attempt to use overdried or brittle sheets but endeavour to condition them by allowing them to absorb a little moisture from the air.

Use only pure crystal bichromate and not cheap commercial grades which often contain acidic or alkaline impurities which affect sensitivity and useful life.

STRENGTH OF SENSITISER AND NEGATIVE CONTRAST

The strength of the sensitising bath must be suited to the contrast of the negative to be used : thus, pigment paper

to be printed behind a contrasty negative requires a more concentrated sensitiser than for a soft negative. It is, however, desirable that the gradation of negatives used in this process should be soft, *i.e.*, showing a difference between maximum and minimum densities of, say, 0.8 to 0.9. Measuring densities of negatives requires special apparatus (*e.g.*, visual comparator or photo electric density meter) and workers not possessing such apparatus must work by a method of trial and error until experience has been attained. As a guide, negatives with the suggested range of 0.8 to 0.9 should be printed, using a high pressure mercury vapour lamp as the printing light, on blue and red pigment paper sensitised in a 3% potassium bichromate solution. Even if all negatives of the colour set are of equal contrast the yellow pigment paper will require a 1% weaker sensitiser than the blue and red, since it prints with a softer scale of gradation. Suggested sensitiser concentrations for negatives of different contract range are as follows.

Contrast range of negative	*Sensitiser*	*Strength*	*Light source*
0.8—0.9	Potassium bichromate	3%	High pressure mercury vapour lamp
0.9—1.0	,, ,,	4%	,, ,,
1.0—1.1	,, ,,	5%	,, ,,
1.1—1.2	Ammonium bichromate	6%	,, ,,

N.B.—The yellow pigment paper should in all cases be sensitised in a solution 1% weaker than the red and blue.

If the negatives are printed by diffused daylight, which gives a brighter result than the high pressure mercury vapour lamp, the sensitiser strengths must be increased by 1%. Open arc lamps give contrasts very similar to high pressure mercury vapour lamps. Enclosed arc lamps give less contrast than open arcs.

As printing is done by contact some workers may prefer to make enlarged negatives. Making such negatives gives an opportunity to adjust the contrast to suit the requirements of the process. Of course, if the original negatives are in balance the worker will take care not to disturb this balance either in the intermediate positives or final enlarged negatives. If the original set of negatives is out of balance or of incorrect contrast it is permissible to correct both balance and contrast at either or both stages of the enlarging procedure. Exceptional experience and/or the assistance of density measuring apparatus is, however, necessary to make a success of such corrections.

DETERMINATION OF EXPOSURE

As small variations or inaccuracies of exposure can make or mar a colour print it is almost essential to expose with a steady light source. The high pressure mercury vapour lamp represents in the opinion of the authors the most suitable lamp available, as it has a high actinic light output, and is economical to purchase and run, while its steady burning enables small variations of the time of exposure to be made with certainty as to their effect. The 400-watt type is recommended.

It is not recommended that workers should attempt to gauge exposures by means of an actinometer, as the degree of darkening of the sensitive recording paper cannot be judged with sufficient accuracy. If the worker possesses a density meter and calibrated density step wedge he is advised to proceed as follows. First find the sensitivity of the pigment paper by exposing behind the step wedge at a fixed distance from the lamp for a known convenient time, *e.g.*, 1 minute at 18 inches from a 400 watt high pressure mercury vapour lamp. Develop the printed pigment wedge on a piece of celluloid and note which step of the wedge is just recorded by this exposure ; let us assume that the density of this step is 1.0. Next the maximum density of the negative is measured when, from density tables, it is possible from the data obtained to calculate the exposure necessary just to print through the darkest part of the negative. If the worker has no density meter he can only proceed by visually matching the darkest tone of the negative with a step of the calibrated wedge and then make a calculation and a test exposure and modify this as required. A calculation which will give a very close approximation to the required exposure is the ratio of the opacities of the darkest tone of the negative and that of the step of the wedge which just prints through : for example, if the maximum density of the negative is 1.08 (opacity 12.02), then in the example given above the exposure of 1 minute must be increased to $\frac{12}{10}$ minutes, i.e. 72 seconds. (The opacity corresponding to a density of 1.0 is 10, as log opacity = density. See tables on pages 55/56).

EXPOSURE

Fit the negatives with thin opaque masks in order to provide a " safe edge." Print in a good quality photographic frame and, of course, see that there is no dust between the glass of the frame, the negative, and the sensitised pigment

paper. Formation of Newton rings is best avoided by placing a piece of very thin clear sheet gelatine or celluloid between the printing frame glass and the negative. Set up the frame at a sufficient distance from the printing light to ensure evenness of illumination and to avoid heating the frame glass and keep to this distance both for test exposures and in actual work. Keep a proper and detailed record of all exposures and negatives printed, as such a record will enable duplicates to be produced and will form a valuable guide for further work.

Before finally transferring and combining into a complete print a test can be made by transferring and developing the printed pigment images each on to a separate thin piece of celluloid sheet, *e.g.*, .003″. These prints may be superimposed in register whilst still wet over a piece of white paper and the accuracy of the colour balance judged and any necessary exposure modifications introduced into the making of the final complete print. Prevent extraneous actinic light from reaching the pigment paper before, during and after exposure.

TRANSFER TO TEMPORARY SUPPORT.

Various supports are available and all of those recommended for Trichrome Carbro are suitable. Preparation of the supports is described on pages 12 & 13.

Transfer, which must be done in artificial and non-actinic light, is carried out by the so-called "dry" method. Lay the printed sheet gelatine side down on to the prepared temporary support, and fix it along one edge by means of a piece of gummed or self-adhesive tape. Now feed the support between a pair of rubber covered rollers, *e.g.*, a domestic or photo wringer, until the tape is gripped. Raise the printed sheet and with a small-bore rubber hose or spouted vessel pour a little water on to the support close up to the rollers. The rollers should now be turned slowly so that the support and paper are drawn between them while at the same time a continuous supply of water is fed into the angle between the support and paper. Care must be taken to ensure that the support is always wetted across its full width just before the printed sheet is rolled into contact. The temperature of the water used for transfer is important and should be about 70° F. (21° C.).

If the worker does not possess a wringer the best method of transfer to avoid stretch is the following. After exposing the pigment paper it should be plunged into cold water (65°—

70° F., 18°—21° C.). for ten seconds and immediately placed face down on to a prepared and wetted temporary support and squeegeed down as firmly and as quickly as possible. A flat squeegee is recommended and this operation must not be done in other than artificial non-actinic light.

After transfer, the backing paper and gelatine are relatively dry and the former will not allow water to pass through it very readily. Even development is best obtained by placing the paper and support in cold water for at least 10 minutes before actual development is commenced in hot water. If very rapid penetration is required either industrial methylated spirit or a photographic wetting agent can be applied to the backing paper, but penetration is not so even as with water and care must be taken not to employ a support which will be attacked by spirit.

DEVELOPMENT

Development is carried out exactly as for Carbro but the end point is not so definite and images can be lightened by the use of hotter water. If standardisation is aimed at the water temperature should be controlled at 105° to 110° F. (41° to 43° C.).

TRANSFER TO SOLUBLE TEMPORARY SUPPORT

If the negatives have been made in reverse, transfer of the colour images to Soluble Temporary Support is done in the Carbro order of blue, red, yellow and the combined image transferred to a final transfer paper as described on pages 25 to 28.

If the negatives are not reversed then transfer to Soluble Temporary Support must be made in the order yellow, red, blue and the combined print hardened in 5% formalin solution by soaking for 2 to 3 minutes, rinsing in cold water and hanging up to dry. Register of the red image on the yellow is not simple in ordinary daylight or normal artificial light, but can be facilitated by doing this work near the high pressure mercury vapour printing lamp as this lamp gives very little red light and consequently the red pigment appears much darker in hue.

TRICHROME CARBON PRINTS BY DIRECT ENLARGEMENT.

Direct enlargement on to Trichrome pigment paper through a lens is now possible owing to the high printing speed of Autotype products and the marketing of very actinic compact source lamps.

LAMPS AND EQUIPMENT

The lamp so far used by the Autotype Company Ltd. for its experimental work is the General Electric Company's 500 watt compact source high pressure mercury vapour lamp. Even more powerful lamps are promised and it is understood that lamps of 1,000 and 2,000 and even higher wattage may be marketed.

High pressure mercury vapour lamps do not reach full brilliance until they have been burning for some five minutes and once switched off cannot be re-lit until they have cooled down so that the vapour pressure is reduced sufficiently to allow the arc to bridge the gap between the electrodes. In order to prolong the life of lamps and achieve economy devices can be added which permit the lamp to " simmer " at a lowered wattage, while the operation of a switch will immediately restore full brilliance when required.

Lamps other than that mentioned are manufactured in this and other countries and customers are advised to select the lamp best suited to their apparatus and requirements. Very considerable vapour pressure is built up inside the quartz glass bulb of this lamp and consequently workers are advised to fit their enlarging cameras with a substantial ventilated lamp house and not to jar or examine the lamp while it is burning or cooling down.

The lamp mentioned is designed to burn in a vertical position, so a horizontal enlarging system should be employed. Workers are advised to construct their enlargers in the form of an optical bench on to which the components, viz., lamp, lamp house, condenser, negative carrier, bellows, lens and copy board and holder can be mounted, and made adjustable as required. Some compact source lamps can be burned in a horizontal position, but these generally require to be fitted with a magnetic device which prevents the mercury arc from bowing upwards or otherwise changing position.

The light from the lamp should be directed on to the negative through a condenser of adequate size. Change of the degree of enlargement necessitates alteration of the lamp position and once the lens is in the required position the negative should be removed from the camera and the lamp adjusted until even illumination and maximum brilliance are obtained all over the enlarging surface.

The authors first used a water cooling bath between the condenser and the negative but found the heat absorption and dissipation in the apparatus used was sufficient to enable them to dispense with this somewhat troublesome accessory.

The enlarging lens employed should be one corrected for mercury vapour light and of large aperture, f3.5 or f4.5.

The use of diffusing screens is not recommended, either alone or in conjunction with the condenser system, as the former results in great loss of light, and the second gives granular enlargements.

EXPOSURE

It is advisable to fit all negatives with opaque masks all round the image areas, and no " shading " or " dodging " should be attempted during exposure.

The usual precautions must be taken to ensure that moisture is not deposited either on the lens or the condenser, and on no account should the position of the lamp be altered during exposure or between successive exposures.

Normal separation negatives, such as are made in repeating backs or by consecutive exposures, should be placed in the enlarging camera film side *away* from the lens. This will give reversed prints on the pigment paper, which, when developed on plastic supports, will be the correct way round, and will be reversed again on combining on Soluble Temporary Support, and corrected by transfer to the final paper support.

Negative sets made in " one-exposure " or " one-shot " cameras, however, will usually be found to have one or more of the set reversed. Correction of reversal can be achieved by turning the negative over in the negative holder—care must however be taken to bring the film sides of other negatives of the set into the same plane in their turn by packing out with a piece of clear glass of equal thickness to that of the negatives.

Calculation of the sensitivity of the pigment paper and of exposures required can be carried out as described in the preceding chapter, except that the neutral density step wedge should be placed in the negative carrier and exposed on to pigment paper placed in the frame at the focal position to be employed when the negative is printed. If the negatives are at all stained by developer or for any other reason are not neutral in hue the exposures required will be much longer than indicated by calculations based on visual comparison.

The pigment paper, sensitised and glazed as described in previous chapters, is best held in a suitable printing frame during the exposure, and it will be found convenient to arrange a stand which can support the frame in any desired position on the bench. Focus on a piece of plain white paper mounted in the frame, and mark or fix the exact position of the stand so that the frame can be removed, loaded with sensitised pigment paper, and returned to place without loss of focus. The glass of the printing frame should, of course, be free from scratches or other defects, and should be kept scrupulously clean.

The worker, having calculated or otherwise decided upon the camera exposures, is advised to expose a trial set, preferably including a reproduction of a grey wedge, and to transfer this to and develop on thin clear celluloid, say, .003″ thick. The images should be chilled after development and then superimposed, while still wet, in the order yellow, red, blue, on a piece of wetted white paper. The combined print so obtained should be viewed in a good white light, and whilst allowance is made for the fact that it will look rather lighter than when actually transferred and dried, it should be examined critically and necessary variations in exposure times, to correct colour rendering and density faults, decided upon. If on examination it is decided that the print has adequate shadow density but that the highlights are rather " bald," then it is advised that another trial set should be exposed and " flashing " introduced (see next paragraph). Similarly if the highlights of the first trial print are satisfactory but the shadows too dense, then exposures can be reduced and " flashing " used to retain detail in the highlights.

" FLASHING "

Generally speaking direct enlargement gives more contrast than contact printing with mercury vapour as the illuminant.

Negative sets should therefore be kept soft, and, in order to save exposure time, of low maximum density. If the ideal type of negative is not always obtainable and printed results show a tendency to be too contrasty with loss of extreme highlights then one should resort to the following expedient. First the camera exposure should be sufficient only to reproduce the shadows to their correct density. This exposure will normally result in the loss of the highlights, since the amount of light they have received is insufficient to overcome the inertia of the pigment paper. If now the pigment paper is exposed to a naked light for a controlled time, which exposure is in itself insufficient to fog the print but only to overcome the pigment paper inertia, the highlight exposure is sufficient to record fully. A short exposure to a naked light is generally known as a " flash." " Flashing " can be carried out either before or after the exposure through the negative. The authors have found it more convenient to flash after exposure, and they " flash " to a 400 watt Osira lamp generally for not more than 1 second at 18" from the lamp.

SENSITISING

Since lamps and apparatus are likely to vary considerably it is most difficult to give a table of sensitiser strengths for use with negatives of different contrast ranges. It is recommended that sensitising solutions should be made up and used at 5% to 6% strength as a maximum, and if pigment paper sensitised in such solutions gives results which are too soft then the sensitizer strength should be reduced.

TRANSFER TO PLASTIC TEMPORARY SUPPORT

Transfer in non-actinic light as recommended for Contact Carbon printing. After transfer put the sandwich into cold water for at least 10 minutes before commencing development.

DEVELOPMENT

Develop as for Contact Carbon printing.

Start the development with water at 110° F. (43° C.) and strip off the backing paper with one uninterrupted, firm but gentle pull *before* bubbles form between the gelatine and paper. These bubbles can be seen through the support and when the paper is stripped. If the stripping is left until too late the bubbles will mar smoothness of tone as they leave lighter spots.

If the print has been slightly under-exposed do not attempt to save it by stopping development before completion as this will introduce streaks and patchiness. Prints which are slightly over-exposed can, however, be reduced by prolonging development in rather warmer water. The great majority of development should be carried out by shaking the print on its support under the surface of the water, and only gentle splashing resorted to at any time.

Chill the print in clean cold water and hang it up to dry. Remove any drops of water from the back of the plastic support. Do not hasten drying by heat, but use a fan, which should be far enough away to avoid cockling the support or blowing dust on to the wet gelatine.

TRANSFER

All transfer operations should be carried out exactly as in the Carbon or Carbro Trichrome instructions.

TRICHROME PRINTING BY THE WET CARBON PROCESS

The Wet Carbon Trichrome process is in practically all respects similar to Trichrome Contact Carbon, excepting that the pigment paper is not dried after immersion in the bichromate sensitising solution. The process yields results of fair quality and is useful for making a quick check of the colour separation and balance of a set of negatives.

A brief outline of the process is as follows. First a sheet of thin celluloid, *e.g.*, .003″ thick, is waxed and polished. Then a piece of wet printing pigment paper (AUTOTYPE SERIES 4) is immersed in a bichromate solution for about 2 minutes at 60° F. (15° C.) and is then squeegeed to the waxed side of the celluloid. The backing paper is swabbed over with an absorbent pad or leather, and the celluloid side dried and polished. This sandwich is now placed in a printing frame with the celluloid against the film side of the negative, and the frame closed and exposed to the printing light. After exposure the sandwich is placed in warm water and development carried out in the usual way.

PREPARING THE PLASTIC SUPPORT

Cellulose nitrate (celluloid) .003″ thick has been found the most satisfactory support, as it does not change shape noticeably when wetted by hot or cold water. Waxing should be carried out as previously described and it is a considerable help if one edge of the thin celluloid is clipped down to a board or stiff card.

SENSITISING

Immerse the piece of waxed celluloid in the bichromate solution together with the pigment paper. The sensitiser strength should be varied to suit the contrast of the negative to be printed. Keep the temperature of the sensitising solution low, and do not let it exceed 65° F. (18° C.). Remove any air bells which form on either side of the paper. Usually an immersion time of 2 minutes is adequate except when the sensitising temperature is very low. After sensitising withdraw the celluloid and pigment paper from the bath and squeegee together with the gelatine coating of the paper in contact with the waxed surface of the celluloid. The

squeegee should have a good straight edge free from cuts, nicks and other defects, and the celluloid should be flat and free from kinks. Now wipe the backing paper with an absorbent pad or leather, turn the sandwich over on a smooth flat surface, and carefully dry and polish the celluloid. Do this polishing carefully so that the soft swollen gelatine is not marked or stressed. Leave the sandwich on one side in a cool place for 5—10 minutes before placing it in the printing frame.

PRINTING

Fit an opaque mask around the outside of the negative and place in a printing frame with a thin gelatine or other foil between the negative and glass of the printing frame to prevent formation of " Newton Rings." Put the celluloid side of the sensitised sandwich against the film side of the negative and cover the back with some non-absorbent material such as celluloid, glass or waxed paper to prevent undue evaporation of moisture. The wax paper, if used, should be unbruised, otherwise moisture will escape and affect evenness of printing. Now close the frame so that the pressure on the sandwich is as even as possible. It is desirable to use a steady burning source of light such as a high pressure mercury vapour lamp as recommended in earlier chapters, or a " Photoflood." Do not allow the frame to get warm during exposure. Place a sheet of glass between the frame and light, and if necessary blow air between the glass and frame in order to remove heat. If the room temperature is much above 70° F. (20° C.) the process becomes difficult as the wet swollen gelatine is prone to melt or mark in the printing frame.

Provided that the intensity of the light is not variable exposures may be judged by time, but otherwise (for example, when printing by daylight, on a day when clouds frequently pass in front of the sun) an Actinometer must be used to record the true amount of exposure given.

The following are specimen exposure times to No. 1 " Photoflood " and 400 watt " Osira " high pressure mercury vapour lamps. Distance between light source and printing frame 16″.

The pigment papers were each sensitised for 3 minutes in 4% potassium bichromate at 56° F. (13° C.) and squeegeed to celluloid .003″ thick.

Negative size 6½ x 8½.

End densities of Negatives		EXPOSURE TIME *No. 1 Photoflood*	*400 watt Osira*	*Number of Tints Autotype Trichrome Actinometer*
YELLOW	1.7—0.2	5½ minutes	4 minutes	3½ tints
MAGENTA RED	1.75—0.2	3¾ minutes	2¾ minutes	2¼ tints
CYAN	1.7—0.2	3½ minutes	2½ minutes	2 tints

As will be seen from the end densities quoted this test set consists of somewhat bright negatives, hence the use of 4% potassium bichromate sensitising solution.

FLASHING

The flashing technique which is fully described in the preceding chapter, can be used with great advantage in the wet process. Since the sensitivity of bichromated gelatine paper is lower when wet than in the dry state as used in the Carbon process the flash exposure must be correspondingly extended. A flash exposure of 5 seconds at 18″ from a 400 watt " Osira " high pressure mercury vapour lamp has been found to give good results and to assist in the retention of delicate highlights without over-all fogging of the whites.

DEVELOPMENT

Remove the celluloid from the printing frame and place it in water at about 90° F. (32° C.), and peel the backing paper as soon as it will come away readily and before bubbles are formed between the gelatine and celluloid. Do not start development at higher temperatures, otherwise the delicate tones of the image will be marked and generally mottled. Develop thoroughly and completely by raising the water temperature to 105° F. (41° C.), and by gentle splashing. Then chill in cold water.

EXAMINATION OF THE IMAGES BEFORE TRANSFERRING

At this stage the worker can check the colour balance of the print by carefully assembling the three images each on its celluloid support, on top of a piece of wet white paper. First soak the paper and lower the wet yellow image upon it.

Pour cold water over the yellow and then put the red image in register with it, moving the red one carefully so as not to damage the yellow. Repeat the process with the blue image. The fact that the prints are still wet will make the picture look lighter than it will appear when transferred and dried, and allowance should be made for this important fact. If the colour rendering is not considered satisfactory the density of any of the three images can be reduced by further development in warm water. There is a limit to the amount of adjustment which can be made in this way and the best results can only be attained by careful attention to exposure times. After the worker is satisfied with his prints they should be separated, rinsed in cold water and hung up to dry.

The images can now be picked up on to Soluble Temporary Support No. 214 in the order yellow, red, blue and treated exactly as for Trichrome Carbon.

ANAGLYPH PRINTS AND TRANSPARENCIES BY THE CARBON AND CARBRO PROCESSES

An anaglyph is a reproduction in two complementary colours from a pair of steroscopic negatives. The colours usually chosen are red and green, one print being made in green from one of the negatives while the other negative is printed in red. When making an anaglyph print the two colour images are superimposed with slight lateral displacement, and are then viewed through coloured spectacles, one eye piece of which is green and the other red. Viewing the transparency or paper print in this way each eye sees one print only and an illusion of depth is obtained. The process has many uses, both commercial and artistic, and has the advantage that a number of persons, each wearing suitable spectacles, can see a stereoscopic image at one time.

Readers interested in stereoscopic photography should consult some of the excellent books on the subject, *e.g.*,

" Stereoscopic Photography " ... ... *W. A. Judge*
" Practical Stereoscopic Photography " *Dr. J. Moir Dalzell*
" Photography, Theory and Practice " ... *M. le Clerc*

Anaglyph prints can be made by either the Carbon or Carbro process, using Autotype Anaglyph colours Red and Green.

CARBON ANAGLYPHS

Sensitise the anaglyph pigment papers as for Trichrome Carbon and, as soft prints are desirable, use a bichromate sensitiser of suitable strength. Print the anaglyph red pigment paper behind the right-hand negative, and the anaglyph green behind the left-hand negative. Develop the colour prints on prepared plastic temporary supports exactly as for Trichrome Carbon. The densities of the colour images should be such that when backed with white paper and viewed through the complementary colour spectacle glass they should appear to have normal density and full gradation. The prints should be allowed to dry on the plastic supports and should then be transferred to a piece of Soluble Temporary Support paper in the order red first and green second. The green image should be superimposed about 1/16″ to the left of the red image. Coloured spectacles should be worn during the positioning of the green image and its position in relation to the red image, already on the Soluble Temporary Support paper, should be that which is found to give the greatest stereoscopic effect.

If the anaglyph is to be left on paper then the combined print should be hardened in a 5% solution of formalin or potash alum solution, then rinsed in water and hung up to dry.

The effectiveness of the anaglyph is increased greatly if the print is carefully trimmed and then mounted on to a black surfaced card. Do not leave any white margin.

If the anaglyph is to be transferred to glass for projection purposes then the combined print should be trimmed to the size of the glass, wetted in cold water for about one minute, and then squeegeed to the coated glass and left until the backing paper feels dry to the hand. Pour a little spirit on to the backing paper and then immerse in hot water at 105° F. (41° C.), and peel away the paper support and wash off any soluble gelatine by gentle laving. Chill in cold water and rack to dry.

The glass must be coated with hardened gelatine, and can be prepared as follows. Make up a 2% solution of a good hard clean gelatine, *e.g.*, Nelson's No. 1, and add a little bichromate, say 0.15%, that is, just enough to colour the solution a pale orange yellow colour. Strain the gelatine solution through a piece of fine muslin and pour on to the glass which should be carefully cleaned and free from grease. Drain off the surplus gelatine coating and place in a rack to dry. Drying must take place in actinic light so that the bichromate hardens the coating. The gelatine coating can also be hardened with chrome alum which has the advantage that it does not discolour the gelatine to the same extent as bichromate. The amount of chrome alum to add to the gelatine depends upon its characteristics, but generally one can proceed as follows. Make up a 5% solution of gelatine and add to this 0.2% of chrome alum. The gelatine should be tested with litmus paper, and if found to be acid, neutralised with ammonia. The chrome alum should be dissolved in water to form a 5% solution and 1 oz. of this solution should be added to each 32 ozs. of gelatine solution. After coating with this solution the glasses should be placed in a horizontal position until the gelatine has set and then racked to dry. This gives a thicker coating than the first method.

As an alternative to coating glasses as above, spoiled dry plates can be bleached, fixed, and washed and hardened. If formalin has been used for hardening then the glass should be washed very thoroughly and then not used for several

days so that the formalin will completely dry out, and so will not harden the Soluble Temporary Support paper coating.

Carbon anaglyphs printed and transferred to glass as described will be reversed and must be viewed through the glass.

CARBRO ANAGLYPHS

The stereoscopic negatives are printed on to unsupercoated bromide paper either by contact or enlargement. The prints are marked " left " and " right " according to which negative of the pair has been used in printing, and Carbro prints are made from these bromides by the standard Carbro method previously described. An anaglyph green Carbro image is made from the left Bromide, and a red from the right. These prints should be developed on plastic temporary supports, picked up on Soluble Temporary Support, first the green and then the red, and transferred to final support paper as described above. Since the final print should have the red image 1/16″ to the right of the green the images are picked up on Soluble Temporary Support with the green to the right of the red, and the final transfer corrects the positioning. If the worker desires to leave the images on Soluble Temporary Support he should reverse the bromides and then assemble on Soluble Temporary Support red first and green second. Carry out all subsequent operations as described for Anaglyphs by the Carbon process.

Viewing spectacles can be purchased or made by fitting suitable colour filters to cardboard frames. The filters should be so chosen that the green filter will transmit all the green images and be opaque to the red, and the red filter vice versa, thus allowing only one of the component images of the anaglyph to be seen by each eye.

Filters recommended are :

No. 2098 (Red) No. 2217 (Blue-Green)	Manufactured in cellulose acetate by Dufay-Chromex Ltd.
and	
No. 15 (Red) No. 20 (Green)	Manufactured in " Celastoid " by British Celanese Ltd.

TRICHROME TRANSPARENCIES BY CARBON AND CARBRO

When making Trichrome transparencies for projection it is advisable to use Autotype Trichrome pigment paper SERIES 1A for Carbon and SERIES 3 for Carbro, but employing special transparent yellow pigment paper instead of that usually supplied. The density of each colour component should be increased somewhat over paper print densities and should in all cases be matched under conditions of illumination similar to those under which the transparencies will be used.

Final transfer to coated glass should be made as described for anaglyph production. A coating of clear lacquer either sprayed or flowed on is often advantageous, particularly when the slide is not to be fitted with a cover glass.

CAUSES OF TROUBLES IN PROCESSING AND THEIR CURES

CARBRO.

PIN HOLES.

These are small, clear, and generally circular spots which appear when the Carbro print is developed in warm water. They are caused by air bubbles adhering to the surface of the pigment paper whilst in the No. 2 Carbro bath or air trapped during the squeegeeing operation between the pigment paper and bromide print. In the first case the bromide print bleaches fully, but in the second the bromide shows black spots of unbleached silver corresponding to the clear spots in the Carbro.

Cure. Do not allow air bells to form on the pigment paper in the No. 2 bath (or in a single bath solution), but remove them with the tips of the fingers.

See that the surface of the bromide print is covered with a film of water. When hand squeegeeing the two papers together start from one side and make a clean firm sweep right across the full width of the pigment paper, and so drive out any air entrapped when the pigment sheet is lowered on to the bromide.

LIGHT CARBRO PRINTS.

If the Carbro reproduction is lighter than seems justified by the density of the bromide print then the possible causes are the following :

Bromide print insufficiently washed after treatment with dilute acetic acid. Wash for at least half an hour in running water or immerse in a buffer solution at pH 6.5 as recommended.

The Carbro bath has been made up with too high an acid content.

Pigment paper has been immersed for too long in the No. 2 bath.

DARK CARBROS

If the Carbro reproduction relative to the bromide is too dark then the probable cause is that the Carbro bath contains too much hardening agent, *e.g.*, formalin or chrome alum. Alternatively the processing time was too long and the pigment paper has been dried out too far before development in warm water.

Failure of the Bromide Print to Bleach

This seldom occurs and usually only in districts where the tap water is very hard and contains an unusual quantity of lime. Bromide prints washed in such water appear to adsorb lime around the silver grains which are thus prevented from bleaching. The cure is to treat the bromide print with 2% to 3% hydrochloric acid followed by thorough washing, or alternatively and preferably bleach the bromide print in the following solution :

Potassium permanganate	5 grammes
Salt (sodium chloride)	12 grammes
Acetic Acid (glacial)	50 c.c.
Water to make	1,000 c.c.

Clear in metaisulphite solution and re-develop in a bright light in any standard developer for bromide paper. No fixing is necessary, but the prints after redeveloping should be thoroughly washed, preferably in soft water, and finally soaked in Buffer Solution. The prints should not be dried before making fresh Carbros from them.

Mottled Carbros

If the high lights of a Carbro are mottled then the most likely causes in order of probability are :

(*a*) Use of supercoated bromide paper.

(*b*) Bromide print soaked in water for a very long time before processing.

(*c*) Pigment paper over-soaked in Carbro solutions or in solutions at too high a temperature.

(*d*) Poor Squeegee technique.

(*e*) Slight movement during positioning of pigment paper on bromide and lack of sufficient pressure on squeegee.

Loss of Highlights in Carbro.

Causes :

(*a*) Use of supercoated paper.

(*b*) Insufficient soaking in No. 2 bath or insufficient acid content of single bath formula.

(*c*) Bad movement and slow squeegeeing of pigment paper on to bromide print.

Frilling

If Carbros frill, a thing which seldom happens with modern Autotype pigment paper, the probable causes are :

(*a*) Carbro solution temperatures too high.

(*b*) Pigment paper stored in too humid conditions so that it is exceptionally limp.

(*c*) Too long immersion in the Carbro baths.

(*d*) Too much wax left on temporary support after polishing, or the use of wax of unsuitable quality.

Lack of Register of Colour Images

Possible causes are :

(*a*) Bromide paper not all cut from same direction of parent roll or sheet.

(*b*) Slight movement of enlarger.

(*c*) Bromide prints not soaked for a like time and/or long enough.

(*d*) Soluble Temporary Support paper not soaked and stretched enough before commencing transfer.

(*e*) Images on negatives not the same size due either to camera or subject movement during or between exposures.

Failure of Carbro Reliefs to Strip from Plastic Supports

Causes :

(*a*) Supports incorrectly prepared. Too little wax applied Unsuitable wax. Accidental use of unwaxed side of support.

(*b*) Supports which do not require waxing sometimes fail until their surfaces have been treated by polishing with metal polish.

(*c*) Soaking of Soluble Temporary Support in water which is too cold.

(*d*) Inclusion of air between transfers.

(*e*) Attempts to remove Soluble Temporary Support before Carbro reliefs are truly dry.

Failure to Transfer from Soluble Temporary Support to Final Support Paper

Causes :

(*a*) Sandwich of Soluble Temporary Support and final support not dried down enough before development.

(*b*) Bad storage of Soluble Temporary Support which causes gelatine coating to go tough or insoluble.

Dark Combined Prints

Beginners often produce colour Carbro prints which look excellent when held up to the light but are far too strong when viewed by reflected light. The reason for this trouble may be due to reasons given under " Dark Carbros " above, but is much more likely to have been caused by the use of over-exposed bromide separation prints.

Falsification of Colour Rendering

Causes :

(*a*) Negatives and/or bromide prints incorrectly marked with their respective printing or filter colours.
(*b*) Bromide prints not in colour balance.
(*c*) Unequal processing of separate colour sheets.
(*d*) Use of a single bath which has stood too long after mixing, or the use of the same solution for all three colour images instead of freshly mixed solutions for each sheet.
(*e*) Use of bromide prints which have been treated with acetic acid and then washed to different extents, resulting in prints of differing pH.
(*f*) Variations of contrast range of negatives which have not been equalised in the making of the bromide prints.

CARBON

Pigment Paper Melts or Softens Excessively in Sensitising Solution

This trouble is most likely to occur in strong solutions, the temperature of which should be kept as near as possible to 55° F. (13° C.) and certainly not above 60° F. (16° C.). Do not hold swollen pigment paper too long between warm fingers. Turn the edges of sheets coated side inwards, and pick up by the fold so made.

Failure of Pigment Paper to Strip from Glazing Surface

Causes :

(*a*) Glazing surface not clean and/or scratch-free.
(*b*) Sensitiser too warm.
(*c*) Glazing surface too warm.
(*d*) Heat for drying applied too soon after squeegeeing sheet to glazing surface.
(*e*) Over-soaking in sensitiser.

Difficulties and Defects in Development

If the backing paper does not strip easily in warm developing water then the probable causes are :

(*a*) Backing paper not penetrated with cold water as recommended.

(*b*) Pigment paper coating tough or insoluble for one of the following causes :

- i Drying time after sensitising too long.
- ii Use of impure bichromate.
- iii Pigment stored too limp either before or, more important and likely, after sensitising.
- iv Long storage of sensitised pigment paper.
- v Over-exposed to light or fogging to light.

(*c*) Bad penetration followed by long soaking in hot water produces development marks, *e.g.*, clusters of bubbles, causing light markings known as "cauliflowers."

(*d*) If the backing paper is pulled away in jerks or partly out of water then streaks appear which cannot be developed away.

Newton Rings.

These are concentric irregular patterns of light and dark lines, and are caused by printing, with a lamp having a light emission with a line spectrum, through two polished surfaces which are not in perfect contact, *e.g.*, bad contact between the back of a glass negative or film and a printing frame glass. These conditions produce interference and can be cured by interposing between the polished surfaces a soft pliable transparent film which will conform to the irregularities, *e.g.*, thin gelatine or cellophane foil.

Loss of Highlights

If in order to obtain proper detail in the highlights of a print the shadows become too dense then one can infer that the bichromate concentration is too low. The upper limit of sensitising strength is 6% ammonium bichromate, and negatives which give hard prints at this strength even with "flashing" must be considered as unsuited to Carbon printing.

Lack of Contrast

Soft and lifeless prints can be brightened by using weaker sensitising solutions. It is advisable to keep a careful record of sensitiser strengths, and densities of negatives, degree of enlargement and exposure time.

Bichromate Poisoning

Some persons are more susceptible than others to bichromate poisoning and the authors advise that all workers, even those who consider themselves immune, should take precautions when handling this chemical. Use rubber gloves when sensitising and if available apply a barrier cream before putting on the gloves.

Remove from the working bench, etc., any drops of bichromate solution, otherwise they will dry and form crystalline dust which can be most troublesome. Wash out all dishes, dusters, leathers and swabs immediately after use.

DENSITOMETRY
CONVERSION TABLE

$$\text{Density} = \text{Log}\ \frac{1}{\text{Transmission}} = \text{Log Opacity}$$

Density	Transmission	Opacity	Density	Transmission	Opacity	Density	Transmission	Opacity
.02	.955	1.05	.52	.302	3.31	1.02	.096	10.5
.04	.912	1.10	.54	.288	3.47	1.04	.091	11.0
.06	.871	1.15	.56	.275	3.63	1.06	.087	11.5
.08	.832	1.20	.58	.263	3.80	1.08	.083	12.0
.10	.794	1.25	.60	.251	3.98	1.10	.079	12.5
.12	.759	1.31	.62	.240	4.17	1.12	.076	13.1
.14	.725	1.38	.64	.229	4.37	1.14	.072	13.8
.16	.692	1.45	.66	.219	4.57	1.16	.069	14.5
.18	.661	1.51	.68	.209	4.79	1.18	.066	15.1
.20	.631	1.58	.70	.200	5.01	1.20	.063	15.8
.22	.602	1.66	.72	.191	5.25	1.22	.060	16.6
.24	.575	1.74	.74	.182	5.50	1.24	.058	17.4
.26	.549	1.82	.76	.174	5.76	1.26	.055	18.2
.28	.525	1.91	.78	.166	6.03	1.28	.053	19.1
.30	.501	2.00	.80	.158	6.31	1.30	.050	20.0
.32	.478	2.09	.82	.151	6.61	1.32	.048	20.9
.34	.457	2.18	.84	.144	6.92	1.34	.046	21.8
.36	.436	2.29	.86	.138	7.25	1.36	.044	22.9
.38	.417	2.40	.88	.132	7.59	1.38	.042	24.0
.40	.398	2.51	.90	.126	7.94	1.40	.040	25.1
.42	.380	2.63	.92	.120	8.32	1.42	.038	26.3
.44	.363	2.75	.94	.115	8.71	1.44	.036	27.5
.46	.347	2.88	.96	.110	9.12	1.46	.035	28.8
.48	.331	3.02	.98	.105	9.55	1.48	.033	30.2
.50	.316	3.16	1.00	.100	10.00	1.50	.032	31.6

DENSITOMETRY
CONVERSION TABLE

$$\text{Density} = \text{Log}\frac{1}{\text{Transmission}} = \text{Log Opacity}$$

(continued)

Density	Transmission	Opacity	Density	Transmission	Opacity	Density	Transmission	Opacity
1.52	.0302	33.1	2.02	.0096	105	2.52	.0030	331
1.54	.0288	34.7	2.04	.0091	110	2.54	.0029	347
1.56	.0275	36.3	2.06	.0087	115	2.56	.0028	363
1.58	.0263	38.0	2.08	.0083	120	2.58	.0026	380
1.60	.0251	39.8	2.10	.0079	125	2.60	.0025	398
1.62	.0240	41.7	2.12	.0076	131	2.62	.0024	417
1.64	.0229	43.7	2.14	.0072	138	2.64	.0023	437
1.66	.0219	45.7	2.16	.0069	145	2.66	.0022	457
1.68	.0209	47.9	2.18	.0066	151	2.68	.0021	479
1.70	.0200	50.1	2.20	.0063	158	2.70	.0020	501
1.72	.0191	52.5	2.22	.0060	166	2.72	.0019	525
1.74	.0182	55.0	2.24	.0058	174	2.74	.0018	550
1.76	.0174	57.6	2.26	.0055	182	2.76	.0017	576
1.78	.0166	60.3	2.28	.0053	191	2.78	.0017	603
1.80	.0158	63.1	2.30	.0050	200	2.80	.0016	631
1.82	.0151	66.1	2.32	.0048	209	2.82	.0015	661
1.84	.0144	69.2	2.34	.0046	218	2.84	.0014	692
1.86	.0138	72.5	2.36	.0044	229	2.86	.0014	725
1.88	.0132	75.9	2.38	.0042	240	2.88	.0013	759
1.90	.0126	79.4	2.40	.0040	251	2.90	.0013	794
1.92	.0120	83.2	2.42	.0038	263	2.92	.0012	832
1.94	.0115	87.1	2.44	.0036	275	2.94	.0012	871
1.96	.0110	91.2	2.46	.0035	288	2.96	.0011	912
1.98	.0105	95.5	2.48	.0033	302	2.98	.0010	955
2.00	.0100	100.0	2.50	.0032	316	3.00	.0010	1000

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